Lessons Testers Can Learn From Astronauts
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The Mission
• NASA’s mission is to pioneer the future in space exploration, scientific discovery and aeronautics research.
• NASA’s mission statement:
  • To improve life here,
  • To extend life to there,
  • To find life beyond.
• NASA’s vision statement:
  • To understand and protect our home planet
  • To explore the Universe and search for life
  • To inspire the next generation of explorers... as only NASA can.

Myths About Scientists
• Scientists are subject to two dominant myths
  1. Scientists are absolutely special people.
  2. Scientists are simply sophisticated cooks.

The field of science studies suggests that neither myth is right.
Mike Mullane’s talk shows that astronauts (like other scientists) are highly motivated, highly trained, and quite human.
They are technical leaders, surrounded by other technical leaders.

- Simon Schaffer and Steven Shapin, Leviathan and the Air Pump
NASA's Not Like Us

- NASA builds all its stuff itself
- NASA sticks to the plan
- NASA has found that you can’t have faster AND cheaper AND better
- NASA’s review process makes sure that communication always happens

Just kidding!

Multiple Vendors, Anyone?

- North American Aviation (now part of Alliant Techsystems)
- Morton Thiokol (now part of Alliant Techsystems)
- Martin Marietta (now Lockheed Martin)
- Rocketdyne (now Pratt & Whitney Rocketdyne)
- North American Aviation (then Rockwell International, then Boeing)

Yes, we deal with multiple vendors. Who argues.

Yes, we change vendors in midstream

Sticking to the Plan

- After the Columbia accident, the CAIB recommended that the shuttle always orbit with the International Space Station
- But when NASA realized this meant not fixing the Hubble, the rule turned into a guideline
- To mitigate risk, they kept a shuttle ready

Cheaper, Faster, and Better

- The Mars Pathfinder and Mars Explorer missions showed a structural weakness in the Iron Triangle.

The problem with the "Iron Triangle" is that it ignores PEOPLE, INNOVATION, and SKILL.
Root Cause Analysis

- In the Apollo V (yes, 5) mission, a 38-second test burn was scheduled. It didn’t happen.
- The conclusion:
  - the SERVICER program that controlled the factors in the descent turned off the engine BECAUSE...
  - it had concluded that the engine had failed BECAUSE...
  - even though there was a fudge factor to account for the fact that it takes time for the engine to start, THAT failed BECAUSE...
  - the Lunar Module’s tanks were only partially pressurized

An Everyday Communications Foul-up

- Normal procedure: On arming, on several seconds before ignition.
- On LM-1 the control valve was suspected of being leaky, SO
- To prevent propellant getting into the engine too early (with explosive consequences), the decision was made shortly before flight, to delay arming the engine until the time of ignition, BUT
- The real reason the engine was slow to start was that propellant had further to travel to reach the engine, not because the tanks were less pressurized, AND
- “It would have been easy for us to adjust the parameter that controlled how long the delta-V monitor waited before testing the engine—but nobody told us.”

Note, by the way, that no person made the decision.

Nope, Nothing New Here

- Actual source code...

```
VRTSTART TS WCHVERT
# Page 801
CAF TWO # WCHNURSE = 2 ---> VERTICAL: P65,P66,P67
TS WCHNURSE
TS WCHNURSE
TC BANKCALL # TEMPORARY, I HOPE HOPE HOPE
CASR ST.direction # TEMPORARY, I HOPE HOPE HOPE
TC DOWNSFLAG # PERMIT X-AXIS OVERRIDE
ADRES XOVINFLG
TC DOWNSFLAG
ADRES XOVINFLG
TCF VERTGUID
```


Engineering Uses Heuristics

- Fallible, “fast and frugal” methods of solving problems, making decisions, accomplishing a task.

“The engineering method is the use of heuristics to cause the best change in a poorly understood situation within the available resources.”

Billy Vaughan Koen
Discussion of the Method
Heuristic

noun: A fallible method for solving a problem or making a decision

• Examples:
  • “Plant your corn early!”
  • Pull on the handle, push on the plate.
  • Problems are cheaper to fix the earlier they’re found.

Heuristic

adjective: “serving to discover”

• Examples:
  • a heuristic approach
  • heuristic guidewords
  • heuristic models

Trigger Heuristics

• Ideas associated with an event or condition that help you recognize when it may be time to take an action or think in a particular way.
  • Like an alarm clock for a slumbering mind
  • When you notice that you don’t have questions, ask “Why don’t I have any questions?”
  • When you feel an emotion while testing, look into it.

Subtitle Heuristics

• Help you reframe an idea so you can see alternatives and bring out assumptions during a conversation.
  • No user would ever do that.
  • No user that I’ve thought of, and that I like, would do that on purpose.
Which Is Why...

All is heuristic.

• Billy Vaughan Koen

Heuristics of Consistency ("this agrees with that"): an important theme in oracles

• History: The present version of the system is consistent with past versions of it.
• Image: The system is consistent with an image that the organization wants to project.
• Comparable Products: The system is consistent with comparable systems.
• Claims: The system is consistent with what important people say it’s supposed to be.
• User’s Expectations: The system is consistent with what users want.
• Product: Each element of the system is consistent with comparable elements in the same system.
• Purpose: The system is consistent with its purposes, both explicit and implicit.
• Statutes: The system is consistent with applicable laws.
• Familiarity: The system is not consistent with the pattern of any familiar problem.

Internalize this checklist, and you’ll have testing ideas.

Heuristics: A Catch

We only learn about the limits of a heuristic solution when it fails.

Heuristics Are Fallible

• Heuristics require skilled practitioners
• They’re context-dependent
• They may contradict each other BUT
• Because they are reasonable, low-cost shortcuts, heuristics can present more valuable solutions for the present circumstances because they’re less complete.
• They can substitute for complete and rigorous analysis.

“Heuristic reasoning is not regarded as final and strict but as provisional and plausible only, whose purpose is to discover the solution to the present problem.”
- George Polya, How to Solve It
Testing Isn’t Just Checking

- Checking is a process of confirming and verifying existing beliefs
- Checking can (and I argue, largely should) be done mechanically
- It is a non-sapient process

I'm very fast...
but I'm slow.


What IS Checking?

- A check has three attributes
  - It requires an observation
  - The observation is linked to a decision rule
  - The observation and the rule can be applied

without sapience

Oh no! What Is Sapience?

- A sapient activity is one that requires a thinking human to perform
- A non-sapient activity can be performed by
  - a machine (quickly and precisely)
  - or by a human that has decided NOT to think (slowly and fallibly)
  - looks like machines win there, right?
- BUT our job is not merely to test for repeatability, but also for adaptability and value

These Guys Are COOL!

…but they are extensions of human capability, not replacements of it. They give us mediated experience.
These Guys Are COOL!

Humans invent them, design them, construct them, program them, launch them, direct them, control them, and decommission them.

Automation Can’t…

- anticipate
- empathize
- recognize
- appreciate
- predict
- teach
- strategize
- learn
- charter
- work around a problem
- make conscious decisions
- collaborate
- model
- troubleshoot
- invent
- get frustrated
- become resigned
- assess
- evaluate
- project
- question
- refine
- investigate
- speculate
- suggest
- contextualize
- elaborate
- reframe
- refocus
- troubleshoot
- recognize new risks
- feel
- think

FEEL

THINK

Testing IS Exploring

- Testing as I see it is all about exploration, discovery, investigation, and learning
- Testing can be assisted by machines, but can’t be done by machines alone
- It is a sapient process


...and that’s why people are crucial.

- Humans are variable, but also adaptable.
- Humans comprehend human value.
- Humans know how to explore.
## Exploratory Skills and Tactics

- Modeling
- Resourcing
- Questioning
- Chartering
- Manipulating
- Collaborating
- Generating & Elaborating
- Overproduction
- Abandonment
- Recovery
- Refocusing
- Altering
- Refining & Backtracking
- Conjecturing
- Recording
- Reporting
- Tooling

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## We’re All Dealing With Complexity

- Modeling is the process of representing complex things with simpler things.

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### Modeling

- A simpler representation of a more complex idea, object, or system that helps you to understand, control, observe, or explore it.

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Resourcing

Sometimes we get all the funding, people, and equipment we need.

Sometimes we have to adapt our tools.

Sometimes we have to go with whatever’s available at hand

Chartering

• Chartering is the process of initiating and guiding exploration.
• How do we guide astronauts?
• How do we guide testers?
• With charters and skill, you can deal with
  • less supervision
  • less documentation
  • more challenging contexts
Guideword Heuristics

- Words or labels that help you access the full spectrum of your knowledge and experience as you analyze something.
- Often provided in the form of a taxonomy, a classification system in (typically) a hierarchical structure.
- Often provided as checklists

Guideword Heuristics for The Most Expensive Test Projects In History

Concise Documentation

Plenty of Documentation ISN’T for Everyone

The Cuff Checklist

Some documentation is written and read with lots of information missing, for use by trained and skilled people.
Reviewing Test Data Indicates Conservatism for Tile Penetration

- The existing SOFI on tile test data used to create Crater was reviewed along with STS-87 Southwest Research data
  - Crater overpredicted penetration of tile coating significantly
    - Initial penetration to described by normal velocity
      - Varies with volume/mass of projectile (e.g. 200ft/sec for 3cu. In)
    - Significant energy is required for the softer SOFI particle to penetrate the relatively hard tile coating
      - Test results do show that it is possible at sufficient mass and velocity
    - Conversely, once tile is penetrated SOFI can cause significant damage
      - Minor variations in total energy (above penetration level) can cause significant tile damage
    - Flight condition is significantly outside of test database
      - Volume of ramp is 1920cu in vs 3 cu in for test

Spray-On Foam Installation

Questions to Ask About Reports

- Who is your audience?
  - People you’ve never met will read your report.
  - Consider that executives may be novice readers in your domain
  - Jargon is very useful, but context-specific
- What’s the summary?
  - What is the meaning of your observation?
  - What is the significance?
  - What’s the worst thing that could happen?
  - What lies beyond the summary?
    - If you don’t want to get fooled, you’d better look far beyond the summary

• Read The Cognitive Style of PowerPoint

Available at http://www.edwardtufte.com/tufte/books_pp
More Questions About Reports

- Does “significant” mean “detectable” or “everybody dies”?
- Watch for the scope of the analysis
  - what’s in, what’s out?
- Watch for pronouns and vague words
  - example: “it works”
  - example: “loss of crew”, vs. DEATH
- Watch for units of measurement expressed inconsistently
  - aggregation is always tricky

To test is to compose, edit, narrate, and justify two parallel stories.

You must tell a story about the product...
...about how it failed, and how it might fail...
in ways that matter to your various clients.

But you must also tell a story about testing...
...how you configured, operated and observed it...
...about what you haven’t tested, yet...
...or won’t test, at all...
...and about why what you did was good enough.

Two Key Questions
(for yourself or others, from Tufte)

- What is the presenter’s story?
- Can you believe the presenter’s story?

Shuttle Training

Not just simulators, but simulations.
Increasingly challenging non-routine scenarios.
800 practice landings, before the pilots do it for real.
### Pilot Training

- Commercial (regional) airline pilots used to spend 2000 hours in in-flight training time; now as little as 300 hours
- at the majors, 5,000 hours of in-flight experience is typical
- Training time can shorter because, with simulators, pilots can be put into extreme or emergency situations quickly
- New pilots are paired with senior pilots
- “The quality of training is what's crucial, not the raw numbers of hours in a candidate's logbook. From a passenger's point of view, you don't want the most experienced crew, you want the best trained crew.”
- Why isn’t testing more like this?

http://www.salon.com/tech/col/smith/2008/09/05/askthepilot289/

### What is Leadership?

- Leaders both require and grant freedom and responsibility to optimize the quality of work
- Leaders don’t blindly follow scripts
- Leaders must respond, flexibly and adaptably, to whatever complexity the situation presents
- A leader must observe keenly, learn rapidly, and decide (appropriately) quickly
- A leader must motivate, organize, innovate

### Normalization of Deviance

**An antidote:**

**POSITIVE DEVIANCE**

### So You Want Process Improvement?

The Positive Deviance approach is
- an asset-based,
- problem-solving, and
- community-driven
- approach that
  - enables the community
  - to discover these successful behaviors and strategies and
  - develop a plan of action
  - to promote their adoption by all concerned.

Source: The Positive Deviance Initiative
http://www.positivedeviance.org/
Positive Deviance

Positive Deviance is based on the observation that
• in every community
• there are certain individuals or groups
• whose uncommon behaviors and strategies
• enable them to find better solutions to problems than their peers,
• while having access to the same resources and
• facing similar or worse challenges.

Source: The Positive Deviance Initiative
http://www.positivedeviance.org/

Positive? Deviant?

• Positive
  • “doing things right”
• Deviant
  • “engaging in behaviour that others do not”

A tester is someone who knows that things can be different.  
--- Jerry Weinberg

PD isn’t limited to testers, of course. 
Anyone, everyone, can contribute. 
Testers, as the antennae of the project, should be on the 
lookout for PD opportunities.

An Example of Positive Deviance

• Problem: Hospital staff wear disposable gowns that can 
become contaminated by contact with MRSA patients. The 
garbage gets full and overflows quickly, risking more 
contamination.

Enter Jasper Palmer

Source: The Positive Deviance Initiative
http://www.positivedeviance.org/
Testing Is Strengthened By Diversity

- Educational experience
- Writing skill
- Cultural background
- Domain knowledge
- Temperament
- Gender
- Programming skill
- Testing experience
- Age
- Experience in the current culture
- Experience *outside* of the current culture

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Testing’s Mission

- Testing’s mission is to pioneer the future in exploration, discovery, investigation, and learning (research).
- Development's mission statement:
  - To improve stuff here,
  - To extend stuff to there,
  - To find stuff beyond.
- Testing’s vision statement:
  - To understand and protect our products
  - To explore the product and search for bugs
  - To inspire the next generation of explorers... as only testers can.